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ACQUISITION OF THE VERTICAL TAKE-OFF AND LANDING TACTICAL UNMANNED AERIAL VEHICLE

Report No. D-2002-026 December 14, 2001

Office of the Inspector General
Department of Defense

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Acronym

VTUAV	Vertical take-off and landing Tactical Unmanned Aerial Vehicle

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202–4704

December 14, 2001

MEMORANDUM FOR NAVAL INSPECTOR GENERAL

SUBJECT: Audit Report on the Acquisition of the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle (Report No. D-2002-026)

We are providing this report for review and to obtain comments and a statement of actions to be taken. This report discusses the readiness of the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle to enter full-rate production.

The Assistant Secretary of the Navy (Research, Development and Acquisition), the Deputy Chief of Naval Operations (Warfare Requirements and Programs), and the Program Manager, Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle, did not respond to the draft report. DoD Directive 7650.3 requires that all recommendations be resolved promptly. We request that management provide comments by January 14, 2002.

We appreciate the courtesies extended to the audit staff. For additional information on this report, please contact Mr. John E. Meling at (703) 604-9091 (DSN 664-9091) (jmeling@dodig.osd.mil) or Mr. Douglas P. Neville at (703) 604-9076) (DSN 664-9076) (dpneville@dodig.osd.mil). See Appendix F for the report distribution. The audit team members are listed inside the back cover.

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Acting
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Office of the Inspector General, DoD

Report No. D2002-026 **December 14, 2001**
(Project No. D2001AE-0080)

Acquisition of the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle

Executive Summary

Introduction. The Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle system will operate from ships and land to provide reconnaissance, surveillance, and target acquisition and to relay communications for littoral operations of the Navy and Marine Corps. The Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle system will collect and pass information to provide the commander with an extended battlespace situational awareness and information superiority, contributing to full-dimensional protection of the force and precision engagement of the enemy. The program office estimates that 23 systems will cost $171 million for research, development, test, and evaluation and $873 million for procurement. The full-rate production decision is scheduled for January 2004.

Objectives. The objective was to evaluate the overall management of the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle. Because the program was in the engineering and manufacturing development phase, we determined whether management was cost-effectively developing and readying the system for the full-rate production phase of the acquisition process. In addition, we evaluated the management control program as it related to the audit objective.

Results. Overall, the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Office was cost-effectively developing and readying the program for the full-rate production phase. However, three areas warrant management attention before the program enters full-rate production.

- The Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Manager developed a schedule-driven acquisition strategy rather than an event-driven acquisition strategy to achieve a directed initial operational capability date of September 2003 for the system. As a result, the program manager is proceeding with an acquisition strategy that includes high-risk items, which may not be resolved before the scheduled production milestone decision and may require the program manager to add time and funds for research, development, test, and evaluation to the budget to complete system development (finding A).

- The Navy had not justified and documented the number of Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle systems that were stated as required. Until the Navy validates and documents the procurement requirements, the Navy will not know whether it will be able to fully fund, through programming and budgeting, the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle program in the Future Years Defense Program (finding B).

- The Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Manager proposed, and the Assistant Secretary of the Navy (Research, Development and Acquisition) approved, exit criteria that were based on minimum program accomplishments specified for each acquisition phase rather than on program-specific accomplishments. As a result, the milestone decision authority will not be able to use program-specific exit criteria in deciding whether the VTUAV should progress within the engineering and manufacturing development phase or continue to the production phase of the acquisition process (finding C).

Appendix A summarizes the review of the management control program.

Summary of Recommendations. We recommend that the Deputy Chief of Naval Operations (Warfare Requirements and Programs) submit a revised initial operational capability date to the Joint Requirements Oversight Council for validation to accommodate an event-driven acquisition strategy. Based on a revised initial operational capability date, we recommend that the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Manager establish an event-driven acquisition strategy to reduce program risk. We also recommend that the Deputy Chief of Naval Operations (Warfare Requirements and Programs) justify and document the number of Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle systems that are required before the full-rate production decision. We also recommend that the Assistant Secretary of the Navy (Research, Development and Acquisition) enforce the requirement that the program manager propose program-specific exit criteria for the remaining acquisition decision points.

Management Comments. Management did not comment on the draft report issued on October 5, 2001; therefore, we request that the Assistant Secretary of the Navy (Research, Development and Acquisition), the Deputy Chief of Naval Operations (Warfare Requirements and Programs), and the Program Manager, Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle, provide comments on this report by January 14, 2002.

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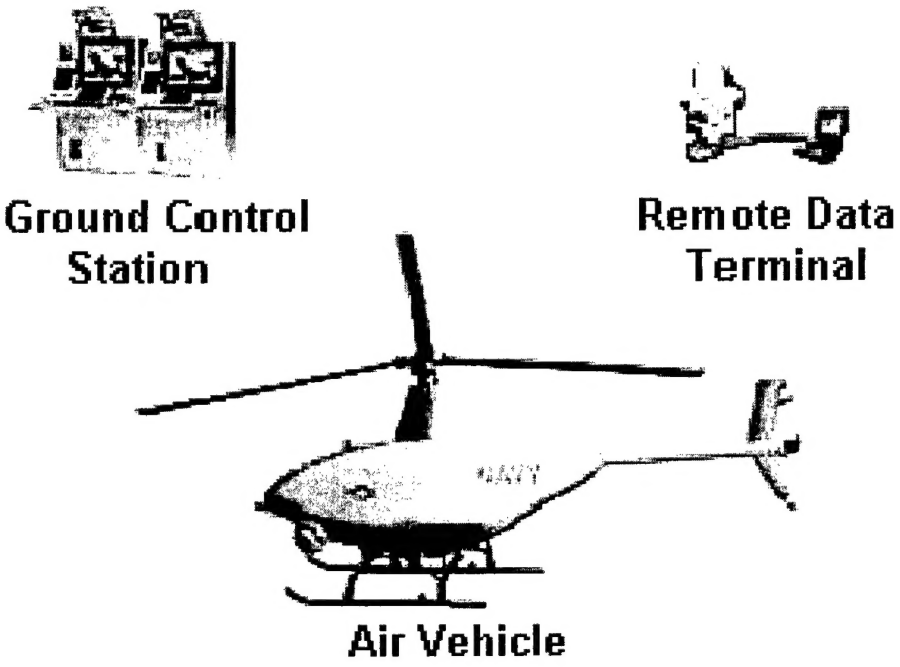


Source: Naval Air System Command, Unmanned Aerial Vehicle Program Office

Key Components of the Vertical Take-off and Landing Unmanned Aerial Vehicle

Background

The changes in strategy in the post-cold war world shifted the operational focus of the Navy and Marine Corps from the open oceans to littoral regions[1], which increased the importance of providing those forces with an integrated reconnaissance asset. A variety of unmanned aerial vehicles has been developed and evaluated by the Services.

During Operation Desert Storm, the Pioneer Unmanned Aerial Vehicle (Pioneer) was successful in providing real-time data to the battleship and increased the effectiveness of its guns. However, the Pioneer also showed the limitations of trying to adapt a system designed to use a runway to the constrained shipboard environment.

Since 1990, the Navy has supported the demonstration of different vertical take-off and landing unmanned aerial vehicles to find a system better suited to the naval environment. New, unmanned aerial vehicle concepts that are in development include miniature, long endurance, and high altitude systems; however, the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle (VTUAV) is the only system in development that is intended to meet the unique operational requirements of both the Navy and the Marine Corps.

The Navy and Marine Corps will use the VTUAV, deployed from ships and land, to provide reconnaissance, surveillance, and target acquisition and to relay communications for littoral operations. The VTUAV system will collect and pass information to provide the commander with an extended battlespace situational awareness and information superiority, contributing to full-dimensional protection of the force and precision engagement of the enemy. The VTUAV consists of the following three primary components:

- air vehicles capable of carrying various mission payloads,
- ground control stations, and
- remote data terminals.

The Navy will integrate the components through the Tactical Control System software.

On February 8, 2000, the Assistant Secretary of the Navy (Research, Development and Acquisition), the milestone decision authority, approved the VTUAV program to enter the engineering and manufacturing development phase of the acquisition process. The program office estimates that 23 systems will cost $171 million for research, development, test, and evaluation and $873 million for procurement. The initial operating capability is scheduled for September 2003 and the full-rate production decision for January 2004. The VTUAV is a major system, an Acquisition Category II program. Definitions of technical terms are included at Appendix B.

[1]The coastal region or shore zone between high and low watermarks.

Full-Funding Policy

DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," Change 4, May 11, 1999[2], and Secretary of the Navy Instruction 5000.2B, "Implementation of Mandatory Procedures for Major and Non-Major Defense Acquisition Programs and Major and non-Major Information Technology Acquisition Programs," December 6, 1996, define the requirements for full funding of acquisition programs at program initiation. The DoD Regulation and Navy Instruction both require the milestone decision authority to assess affordability at each milestone decision point, beginning with program initiation. Further, the Regulation and Instruction require that the milestone decision authority not approve an acquisition program to proceed beyond program initiation unless sufficient resources, including manpower, are programmed in the most recently approved Future Years Defense Program, or will be programmed in the next Program Objectives Memorandum, Budget Estimate Submission, or President's Budget. Schedule delays and uncertain requirements could affect the amount and the schedule of programmed fund distribution.

Objectives

The audit objective was to evaluate the overall management of the VTUAV. Because the program was in the engineering and manufacturing development phase, we determined whether management was cost-effectively developing and readying the system for the full-rate production phase of the acquisition process. In addition, we evaluated the management control program as it related to our audit objectives. We coordinated our efforts with the General Accounting Office, which provided information based on its previous work with the VTUAV Program Office. See Appendix A for a discussion of the audit scope and methodology, the review of the management control program, and prior coverage related to the audit objectives.

Vertical Take-off and Landing Unmanned Aerial Vehicle Program Generally Well Managed

Overall, the program office was cost-effectively developing and readying the program for the full-rate production phase. Following are specific examples of the approach used by the VTUAV Program Office.

- The program office performed research and testing to determine how the Pioneer could be converted to use a new data link and data link control processor as a risk mitigation effort for the VTUAV program. The

[2]The VTUAV program is subject to the May 11, 1999, version of DoD Regulation 5000.2-R because the program entered the engineering and manufacturing stage of the acquisition process before the June 10, 2001, revision; however, the June 10, 2001, revision contains the same full-funding requirements for acquisition programs.

Pioneer conversion may be necessary because, after the new Navy-wide communication system is initiated in FY 2005, the radio frequency used by the Pioneer will no longer be available. To operate the Pioneer after FY 2005, the Navy would have to upgrade it with a new data link and data link control processor that operate on a different radio frequency. Accordingly, the program office performed the necessary research and testing to identify how the Pioneer could be upgraded to operate on a new radio frequency and provided the research results to the Army for use in developing the Tactical Unmanned Aerial Vehicle.

- The program office used integrated product teams to ensure open communication between the contractors and DoD organizations. The integrated product teams, as evidenced in meeting minutes, were effective forums for sharing information and identifying and tracking issues. The integrated product team members included representatives from various DoD organizations as well as contractors and subcontractors. VTUAV issues addressed at those meetings included risk management, integration of the Tactical Control System, air vehicle design, payload requirements, and strategic planning.

- The prime contractor provided the program office with real-time access to program documentation and an open forum for discussions through an Internet-based program. The Internet-based program linked the prime contractor to the program office, the Naval Sea Systems Command, and the subcontractors. Through the real-time program, the prime contractor tracked risk items, design documentation, test results, and earned value management documentation.

Additionally, we determined that the program office was complying with DoD and Navy regulations in the areas of earned value management, contracts management, the development of a programmatic environmental, safety and health evaluation, implementation of the DoD environmental management process, and estimation of life-cycle costs. However, three areas warrant additional management action before the program enters full-rate production. A discussion of the associated findings follows.

A. Schedule-Driven Acquisition

The program manager established a schedule-driven acquisition strategy, rather than an event-driven acquisition strategy that minimized risks, because he wanted to achieve an initial operational capability date of the fourth quarter of FY 2003, as directed by the Deputy Chief of Naval Operations (Warfare Requirements and Programs) and validated by the Joint Requirements Oversight Council. As a result, the program manager is proceeding with an acquisition strategy that includes high-risk areas, which may not be resolved before the scheduled production milestone decision. In addition, those high-risk areas may require the program manager to add time and funds for research, development, test, and evaluation to the budget to complete the VTUAV system development.

Phases in an Event-Driven Acquisition Strategy

DoD Regulation 5000.2-R requires every acquisition strategy to be event driven and to explicitly link program decisions to demonstrated accomplishments in development, testing, initial production, and life-cycle support. Accordingly, the Regulation identifies the acquisition phases and events that must be completed before the program progresses to the next phase of the acquisition process. The acquisition phases are:

- Phase 0, Concept Exploration,
- Phase I, Program Definition and Risk Reduction,
- Phase II, Engineering and Manufacturing Development, and
- Phase III, Production, Fielding/Deployment, and Operational Support.

Appendix C further defines the acquisition phases of the acquisition process.

Program Office Acquisition Strategy

The Assistant Secretary of the Navy (Research, Development and Acquisition) approved the VTUAV acquisition strategy in July 1999. The VTUAV acquisition strategy states that the accelerated production schedule would require a great deal of simultaneous and interdependent actions to meet the initial operating capability date in the fourth quarter of FY 2003, and would require an engineering and manufacturing development decision in the second quarter of FY 2000. Accordingly, the VTUAV Program Manager tailored the acquisition strategy, including omitting acquisition phases, to meet the accelerated production schedule as follows.

Phase 0 and Phase I. DoD Regulation 5000.2-R states that the number of phases and decision points in the acquisition process can be tailored to meet the specific needs of individual program managers if they are based on an objective

assessment of program risks and the urgency of the user needs. The VTUAV Program Manager tailored the acquisition strategy to omit Phases 0 and I, the phases usually dedicated to reducing program risk, and stated that previous unmanned aerial vehicle programs and technical demonstrations proved the concept of a VTUAV through testing; however, an acceptable technology readiness level had not been demonstrated in previous unmanned aerial vehicle programs and technical demonstrations to warrant beginning the VTUAV program in the engineering and manufacturing development phase of the acquisition process.

Technology Readiness Levels. The General Accounting Office report, GAO/NSIAD-99-162, "Best Practices, Better Management of Technology Development Can Improve Weapon System Outcomes," July 1999, addressed acceptable technology readiness levels that systems needed to demonstrate before they can progress from acquisition Phase 0 through Phase III. The Government Accounting Office reviewed commercial and DoD experiences in incorporating 23 different technologies into new product and weapon system designs. The review showed that the most successful technologies were managed by science and technology organizations until they reached high technology readiness levels. (General Accounting Office definitions of technology readiness levels are shown in Appendix D.) Technology readiness levels outline critical steps of technology development that should be accomplished before that technology is considered mature enough to be inserted into a program. The General Accounting Office reported that a review of DoD and commercial technology development cases indicated that programs demonstrating a high level of maturity before allowing new technologies into product development put them in a better position to succeed. Simply put, the more mature a technology is at the start of the program, the more likely the program will succeed in meeting its objectives. Technologies that were included in a product development before they were mature later contributed to cost increases and schedule delays in those products. The report states that the DoD process for selecting program candidates did not include adequate criteria for assessing the maturity of proposed technology, which resulted in the approval of projects that included immature technologies.

In response to the General Accounting Office report, the Secretary of Defense agreed that technology readiness levels were necessary to assist decisionmakers in determining when and where to insert new technologies into weapon system programs. The Secretary also stated that weapon system managers should determine that technology has matured to a technology readiness level seven before insertion occurs and that there should be an established point for the transition of technologies. The Secretary supplemented the milestone review process with additional guidance in the June 2001 revision to DoD Regulation 5000.2-R. The guidance states that the program manager shall identify critical technologies through the work breakdown structure and perform technology readiness assessments before the milestone decision points for engineering and manufacturing development and production, fielding, deployment, and operational support. The Regulation includes the technology readiness levels as defined by the General Accounting Office.

Readiness Level of the Tactical Control System. One of the critical technologies of the VTUAV system is the Tactical Control System, which will process and disseminate the information collected by the VTUAV. The Tactical

Control System technology should have matured to technology readiness level seven before being inserted as part of the VTUAV program; however, because the Tactical Control System was still in the development process, it had not demonstrated the critical steps needed to meet technology readiness level seven.

The VTUAV acquisition strategy stated that the Navy would reduce risk by first integrating the Tactical Control System with the Pioneer—the predecessor of the VTUAV—before integrating it with the VTUAV. However, because of monetary constraints, the Navy did not complete the integration of the Tactical Control System with the Pioneer. The Navy performed research and testing to determine what needed to be done to make the integration a success, but decided not to spend the estimated $8 million required for the integration effort because the VTUAV was scheduled to replace the Pioneer before it became obsolete.

Previous Unmanned Aerial Vehicles. Since 1988, the Navy participated in two predecessor programs in an effort to demonstrate the concept of using unmanned aerial vehicles to satisfy aerial mission requirements. The results of those development efforts follow.

Hunter Short-Range Unmanned Aerial Vehicle. In 1988, the DoD Joint Project Office initiated the Hunter Short-Range Unmanned Aerial Vehicle (Hunter) program to provide the Army, Navy, and Marine Corps with near-real-time, day and night reconnaissance, surveillance, and target acquisition capabilities. In 1992, limited user testing of the Hunter revealed operational performance deficiencies that included inadequate range, unreliable data links, and the inability to meet specified transport requirements. Notwithstanding those deficiencies, the Defense Acquisition Board granted a low-rate initial production contract for seven Hunter systems in January 1993. Upon delivery of the low-rate initial production systems, beginning in May 1994, Government acceptance tests identified deficiencies with system software, data links, and engines. The deficiencies occurred because DoD did not allow enough time to integrate nondevelopmental components or to perform the analysis required to form a functional logistical support system. The DoD Joint Project Office accepted the Hunter systems in April 1995 and the Navy proceeded with shipboard development and integration with the Hunter despite numerous crashes and the subsequent grounding of the system. In October 1995, the Joint Requirements Oversight Council recommended the termination of the Hunter program. On January 31, 1996, the Defense Acquisition Executive canceled further procurement of the Hunter. At the time of the program's cancellation, 7 low-rate initial production systems, which included 56 air vehicles, had been delivered. Of these air vehicles, 20 had crashed.

Outrider Tactical Unmanned Aerial Vehicle. In December 1995, the DoD Joint Project Office initiated an Advanced Concept Technology Demonstration to find a replacement for the Hunter system. In May 1996, the Naval Air Systems Command, the contracting agent for the DoD Joint Project Office, awarded the contract for the development of the Outrider Unmanned Aerial Vehicle system. The 2-year contract required the delivery of six Outrider systems by March 1998; however, numerous development delays and setbacks reduced the 12 months originally planned for testing to 2 months. Because of the reduced time for testing, the testers were unable to demonstrate that the Outrider system met many of the critical requirements to warrant further production. In addition, the Navy concluded that the technical maturity level of

the engine was not advanced enough to meet the Navy's heavy fuel and short runway take-off requirements. Based on the Outrider's inability to meet those specifications, the Navy determined that it would not accept the Outrider as its Tactical Unmanned Aerial Vehicle system.

Technical Demonstrations. During the prototype technical demonstrations that the Navy conducted for the VTUAV program, the Navy required the contractors to demonstrate that their prototypes were capable of vertical take-off and landing. The technical demonstrations did not include extensive integration of the prototypes with commercial-off-the-shelf items and Tactical Control System software, although those integration efforts were needed to show that the VTUAV technology was at an acceptable maturity level and to prove that that system was ready to enter the engineering and manufacturing development phase of the acquisition process. Despite the limited capabilities of the technical demonstrations and the immaturity of the system, the Assistant Secretary of the Navy (Research, Development and Acquisition) approved the VTUAV program for entry into the engineering and manufacturing development phase.

Phase II. By allowing the program to proceed into the engineering and manufacturing development phase, the VTUAV Program Manager had to manage his program around the resolution of high-risk areas that affected the development of the VTUAV. As of September 2001, the four high-risk areas were:

- Tactical Control System availability and integration,
- air vehicle weight,
- data link control processor software development, and
- vehicle management computer software development.

Tactical Control System Availability and Integration. The Navy awarded a separate contract for the development of the Tactical Control System. The Tactical Control System is the software and software-related hardware that is intended to command and control the VTUAV, the Army Tactical Unmanned Aerial Vehicle, the Air Force RQ-1 Predator Medium Altitude Endurance Vehicle, and future tactical and medium-endurance unmanned aerial vehicles. The software will provide the operator of the unmanned aerial vehicle with the necessary tools for computer-related communications; mission tasking, planning, and execution; and data processing and dissemination.

The VTUAV contractor and the Tactical Control System contractor were working together to integrate the two systems. The two contractors needed to coordinate to ensure that they met the unique VTUAV software requirements. Originally, the VTUAV contractor planned to develop some of the software requirements, test them, and then develop additional requirements; however, the Tactical Control System contractor assumed that the VTUAV contractor would provide a complete software requirements package at the beginning of the process. As a result, the time frames that the VTUAV contractor developed for delivery of the first version of the Tactical Control System software differed from that of the Tactical Control System contractor. The program office, the

VTUAV contractor, and the Tactical Control System contractor developed a plan to reschedule the software deliveries, but the effects of the plan and whether it will alleviate the scheduling risk were unknown. The VTUAV contractor planned to complete the software requirements package by late September 2001, but the program office still considered the software integration to be a high-risk area.

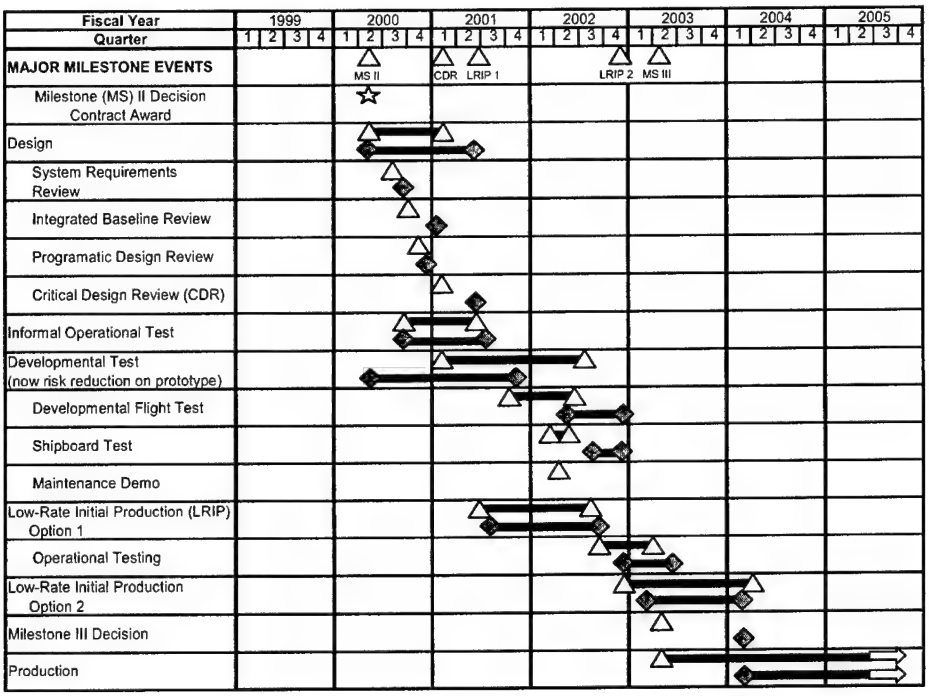
Air Vehicle Weight. The VTUAV contractor could not determine what the projected weight of the air vehicle would be at design maturity. The prototype vehicle weighed 53.7 pounds more than predicted. If vehicle weight reduction measures are not successful, the air vehicle weight may surpass the not-to-exceed-zero fuel weight established by the program office. As a result, air vehicle performance could be degraded, program cost could increase, and further schedule delays could occur.

Data Link Control Processor Software Development. The data link control processor allows the ground control station to communicate to the air vehicle. The data link control processor receives data from the ground control station's Tactical Control System, and then processes and transmits the data to the air vehicle. In the same manner, the data link control processor receives data from the air vehicle, and then processes and transmits the data to the Tactical Control System for dissemination. The data link control processor software contains the ability to interface the Tactical Control System with the air vehicle. The late development of VTUAV software requirements package and design data, however, has also delayed the development of the data link control processor software. Also, the contractor's integration of the ground control station software at multiple sites caused a slower than expected response time for modifications. As a result, the software for the data link control processor will not be developed within established time frames, which may cause a delay in program schedule and increase program costs.

Vehicle Management Computer's Software Development. The vehicle management computer oversees air vehicle operations. The late development of the VTUAV software requirements, the late deliveries of laboratory and flight hardware, and the evolution of requirements throughout the VTUAV development process have delayed the development of the vehicle management computer's software. The inability to develop the software within the established time frames could delay the program schedule and increase program costs.

Effects of Schedule-Related Risk. Three of the four high-risk areas may affect the program schedule. A comparison of the initial program timeline in the VTUAV acquisition strategy and the September 2001 timeline shows the effects of the schedule delays on future program milestones and testing plans.

In the following chart, the triangles represent the original estimates in the VTUAV acquisition strategy and the diamonds represent the program manager's estimates as of September 2001.



VTUAV Engineering and Manufacturing Development Schedule Delays

Schedule slips occurred for nearly all critical events. The most significant schedule change occurred in the area of developmental flight tests.

Developmental flight tests were originally scheduled for completion in the second quarter of FY 2002. The flight tests were delayed until the fourth quarter of FY 2002, because the production representative air vehicles—vehicles in their final configuration—will not be available as scheduled; however there was no corresponding delay in the delivery of the first low-rate initial production system. As a result, the test data from developmental flight tests will have little impact on the low-rate initial production system, which is scheduled for delivery in the third quarter of FY 2002.

Justification for Schedule-Driven Acquisition

In January 1999, the Joint Requirements Oversight Council validated the VTUAV operational requirements document, which included an initial operational capability date of the fourth quarter of FY 2003. The VTUAV Program Manager accelerated the acquisition schedule to meet the initial operational capability date, which coincided with the replacement of the aging fixed-wing Pioneer. The two concerns that preclude the Navy from using the Pioneer beyond FY 2003 are the fielding of the Cooperative Engagement Capability, which is scheduled for fleet induction in FY 2005, and the limited availability of spare parts for the Pioneer. Recent upgrades to the Pioneer, however, have extended its useful life to FY 2007.

Cooperative Engagement Capability. The Cooperative Engagement Capability is a communication system that uses sensor and weapons data from existing systems. It filters and combines the data to create a single, common air defense tactical display, and distributes the information to all combat participants. The result is that all combat participants will have an air picture, based on all sensor data available, that will permit earlier detection and more consistent tracking of air contacts. The Cooperative Engagement Capability will operate using the C-band frequency, but because of extensive communication links needed to successfully implement the Cooperative Engagement Capability, the C-band frequency will not be available to handle other weapon system programs, like the Pioneer, that are not operating in the Cooperative Engagement Capability network. To remain a viable weapon system, therefore, the Pioneer must transition to a different radio frequency for operations or be replaced with another system that operates on a different radio frequency. To transition the Pioneer, the Navy would have to upgrade it, at a cost of $8 million, to include different data links and data link control processors. The Navy chose not to upgrade the Pioneer because the initial VTUAV operational capability date was scheduled before the Cooperative Engagement Capability was to be introduced to the fleet.

Spare Parts. Spare parts are no longer being manufactured for operating the Pioneer ground control stations. Because the Navy does not plan to provide additional funding for upgrades of the Pioneer, the Navy was borrowing parts from decommissioned Pioneer ground control stations to keep the Pioneer systems functioning. The Pioneer Program Office believes that the remaining Pioneer systems can be maintained using the parts from decommissioned systems until the VTUAV is introduced in FY 2003. However, program office personnel stated that the spare parts inventory acquired from overseas markets is sufficient to maintain the Pioneer though FY 2004.

Although the Navy had legitimate reasons for replacing the Pioneer, it had not demonstrated a need for a VTUAV initial operating capability date as early as the fourth quarter, FY 2003. The Cooperative Engagement Capability restriction will affect only sea-based operations of the Pioneer, and the Navy has no plans to deliver sea-based VTUAV systems until FY 2006. Accordingly, the Navy's best interests would be served by extending the initial operating capability date to at least FY 2005 to reduce VTUAV program risks and allow time for the required technologies to mature before the Cooperative Engagement Capability is deployed. Additionally, the Navy should consider the effect of operating the Pioneer with a limited spare parts inventory against the effect of fielding a VTUAV system that may not be ready for fleet introduction.

Effect of Schedule Delays on Program Funding

Schedule delays in the development of the VTUAV have already resulted in a request for additional program funding. In a July 6, 2001, letter to Congress, the Chief of Naval Operations provided a list of programs and requirements that require resources, in addition to those in the original DoD Amended Budget for FY 2002, to maintain force readiness without supplemental appropriations. The letter requested $12.4 billion in additional funding and listed the specific programs and requested dollar amounts for each. The VTUAV program was

identified as one of those programs. The Chief of Naval Operations requested an additional $11 million for the VTUAV program to complete software development and risk reduction testing because of an increased scope of work and associated schedule changes.

Conclusion

The VTUAV Program Manager is proceeding with an acquisition strategy that includes high-risk areas, which may not be resolved before the scheduled production milestone decision. Those high-risk areas may require the program manager to add time and funds for research, development, test, and evaluation to the budget to complete the VTUAV system development. The program manager tailored the acquisition strategy to omit risk reduction efforts normally demonstrated before entering the engineering and manufacturing development phase without supporting evidence that VTUAV technologies were at acceptable technology readiness levels. Further, the Navy did not demonstrate the need to accelerate the VTUAV acquisition schedule to meet a fourth quarter, FY 2003, initial operational capability date because sea-based Pioneer operations will not be affected by the Cooperative Engagement Capability until FY 2005. Accordingly, the Navy's best interests would be served by extending the VTUAV initial operational capability date until at least FY 2005 to reduce program risks and allow time for required technologies, including the Tactical Control System, to mature.

Recommendations

A.1. We recommend that the Deputy Chief of Naval Operations (Warfare Requirements and Programs) submit to the Joint Requirements Oversight Council, for validation and approval, a change to the operational requirements document for the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle to accommodate an event-driven acquisition strategy to reduce program risks.

A.2. We recommend that the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Manager establish an event-driven acquisition strategy to reduce program risks.

Management Comments Required

The Deputy Chief of Naval Operations (Warfare Requirements and Programs) and the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Manager did not comment on a draft of this report. We request that the Deputy Chief of Naval Operations and the Program Manager comment on the final report.

B. Requirements Determination

The Navy had not justified and documented the number of VTUAV that were stated as required because the Deputy Chief of Naval Operations (Resources, Warfare Requirements, and Assessments) had not performed a documented analysis to determine the quantities needed for peacetime or wartime operations and also had not considered the viability and cost-effectiveness of transferring, or cross-decking, VTUAV assets between deployed and nondeployed ships. As a result, until the Navy validates the procurement requirements, the Navy will not know whether it will be able to fully fund, through programming and budgeting, the VTUAV program in the Future Years Defense Program.

Requirement for VTUAV

During 1998 and 1999, the Navy conducted technical demonstrations with vertical take-off and landing unmanned aerial vehicles, including shipboard demonstrations. As a result of the demonstrations, the Navy decided that the vertical take-off and landing capability was technically feasible to meet its mission needs. In November 1998, the Navy submitted its operational requirements document for a vertical takeoff and landing tactical unmanned aerial vehicle that was based on the:

- Joint Requirements Oversight Council's validation of the mission need statement for a close range reconnaissance, surveillance, and target acquisition capability;

- Commandant of the Marine Corps' approval of a mission need statement for a tactical vehicle reconnaissance and surveillance and target acquisition capability; and

- Chief of Naval Operations' approval of the operational requirements document for the Vertical Take-off and Landing Integrated Platform for Extended Range Reconnaissance Unmanned Aerial Vehicle.

In January 1999, the Joint Requirements Oversight Council validated the VTUAV operational requirements document. The VTUAV operational requirements document requires the VTUAV to provide Navy commanders with the near-real-time imagery and data that are required to support intelligence, surveillance, and reconnaissance requirements independent of, or in concert with, the use of manned aircraft or reliance on limited Joint Theater of National Assets. The operational requirements document also states that the VTUAV system will provide the Marine Corps commander with a means to enhance his situational awareness, assist in the engagement of threat forces, exercise command and control, and assess the results of ongoing operational activities. The Navy believes that the ability of VTUAV to rapidly deploy aboard and operate from all air capable ships will provide the flexibility required to meet the needs of tactical commanders at all levels. The operational requirements document specifies an initial requirement of 23 VTUAV systems, 12 for the Navy and 11 for the Marine Corps. Each Navy system includes three air vehicles with support equipment and mission payloads, one land-based and one

sea-based data link, one land-based and one sea-based ground control station, and two remote data terminals. The Marine Corps' system requirement differed from the Navy's in that it replaces the sea-based data link and ground control stations with an additional land-based data link and ground control station.

VTUAV Requirements Determination

In January 1999, the Deputy Chief of Naval Operations (Warfare Requirements and Programs) stated that the VTUAV requirement was based on outfitting each of the Navy's 12 Carrier Groups and the Marine Corps' 11 Amphibious Ready Groups with a VTUAV system. (Appendix E discusses the composition and availability of the Carrier and Amphibious Groups that will use the VTUAV.) Subsequently, the Deputy Chief of Naval Operations stated that the VTUAV requirement was based on the constant deployment of one Carrier Group and one Amphibious Group on each U.S. coast and one Non-Carrier Group and one Marine Prepositioning Force. To obtain constant deployment, each Group would require three additional Groups for rotational purposes, including one in maintenance, one in work-up for deployment, and one in stand down, post deployment. The Marine Prepositioning Force would require only two additional Forces for rotational purposes. Those requirements are summarized in the following table.

Table 1. VTUAV System Requirements Based on Rotational Deployment

	Navy	Marine Corps
Carrier and Amphibious Groups – East	4	4
Carrier and Amphibious Groups – West	4	4
Non-Carrier Battle Groups	4	0
Marine Prepositioning Forces	0	3
Total	**12**	**11**

The rationale for the rotating deployment is not supported by the ship deployment options and schedules as described in the following section, Deployment Options. When asked for additional information, the Office of the Deputy Chief of Naval Operations was unable to provide documentation linking the numbers required to a calculation of actual peace and wartime operations and training and attrition requirements.

Additionally, the Navy did not have documentation to show that the initial requirement calculation considered the total number of sea-based ground control stations that would be necessary to support the intended use of the VTUAV. The initial requirement calculation did not consider the ground control station capability for all air-capable surface combatants, amphibious assault and amphibious transport dock ships, and aircraft carriers.

Air-Capable Ships. The VTUAV operational requirements document states that VTUAVs must operate from all air-capable ships. Personnel from the Office of the Deputy Chief of Naval Operations (Warfare Requirements and

Programs) defined air-capable ships as ships equipped to land an SH-60 helicopter. Using that definition, the Navy will have 116 air-capable ships in its inventory of surface combatants from FY 2003 through FY 2010. Therefore, the VTUAV requirement should include, for each of those ships, some type of sea-based ground control station. The initial full rate production will outfit the Navy with 8 sea-based ground control stations for the surface combatants, leaving 108 surface combatants without a ground control station.

Amphibious Assault and Amphibious Transport Dock Ships. The VTUAV concept of employment, June 1, 1999, states that a sea-based ground control station with an embedded Tactical Control System will be installed on all amphibious assault and amphibious transport dock ships. According to Navy publications, as of September 2001, the Navy had 12 amphibious assault ships and 11 amphibious transport dock ships in its inventory. The initial full rate production will outfit the 12 amphibious assault ships with sea-based ground control stations, leaving 11 amphibious transport dock ships without a ground control station.

Aircraft Carriers. The concept of employment states that, although the Navy does not plan to operate the VTUAV from aircraft carriers, all deployable carriers will be equipped with a stand-alone tactical control capability. The Office of the Deputy Chief of Naval Operations (Warfare Requirements and Programs) stated that of 12 aircraft carriers, 1 carrier is continuously in training. Planned VTUAV production quantities will outfit none of the 11 deployable aircraft carriers.

The program office recognized the need for the additional 108 sea-based control stations for the surface combatants and 11 sea-based control stations for the deployable aircraft carriers in an Out-Year Plan but, because those requirements were not included in the initial program requirements, funds were not budgeted for them. Without considering the requirements for the additional sea-based control stations, the Navy is understating the number required to support the VTUAV mission. The total requirement to meet the needs as defined in the operational requirements document and the concept of employment should be a critical factor in future decisions on the VTUAV program. For example, the Vertical Take-off and Landing Integrated Platform for Extended Range Reconnaissance program was also supposed to perform relatively the same missions as the VTUAV. That program was canceled, in part, because the vast number of systems required to fulfill the intended purpose, as specified in its operational requirements document, would have made the program an Acquisition Category I program that required additional oversight.

Deployment Options

The Navy will store VTUAV systems aboard ships to be used as needed to provide the group commanders with reconnaissance, surveillance, and target acquisition capabilities. When asked about the necessity of outfitting every Carrier and Amphibious Group with a particular weapons system, the Office of the Deputy Chief of Naval Operations (Plans, Policy, and Operation) stated that, in a process known as cross-decking, the Navy routinely transfers limited assets between deployed and nondeployed platforms to conserve resources.

The Air Force has used the cross-decking concept for aircraft-mounted sensors that are assigned to air wings. Specifically, the Low Altitude and Targeting Infrared for Night program used cross-decking as an option in the early stages of production when the number of assets was limited. As the number of assets grew, the Air Force no longer needed to physically remove assets from one platform to another. However, the Air Force still removes Low Altitude and Targeting Infrared for Night assets from nondeployed platforms to create a pool of assets for use on deployed platforms. In addition, the Air Force still cross-decks the support equipment for those assets because it is very costly to outfit every platform with support equipment. Similarly, the Air Force, for the Tactical Airborne Reconnaissance Pad System, cross-decks assets from nondeployed to deployed platforms. Cross-decking of assets does not affect the readiness of the Air Force to perform its mission.

Peacetime Deployment and Wartime Contingencies. Naval Sea System Command personnel stated that, during peacetime, three Carrier Groups are routinely deployed. One Carrier Group is permanently stationed in Japan, and the other two are deployed from the east and west coasts of the United States. The Carrier Groups are deployed off the U.S. coasts in a three Carrier Group rotation—6 months deployed, 6 months in maintenance and resupply, and 6 months in preparation for the next mission. The Amphibious Groups follow the same deployment rotation as the Carrier Groups during peacetime.

The deployment rotation differs from the Carrier and Amphibious Group rotation methodology that the Navy used as the rationale for the number of VTUAV systems required. The peacetime deployment schedule follows.

Table 2. Peacetime Deployment Schedule

	Carrier Groups	Amphibious Groups
Forward Deployed–Japan	1	1
East Coast		
Forward deployed	1	1
Maintenance and resupply	1	1
Preparation for deployment	1	1
West Coast		
Forward deployed	1	1
Maintenance and resupply	1	1
Preparation for deployment	1	1
Total	**7**	**7**

In the event of two near-simultaneous major conflicts, the Navy plans to deploy all available Carrier and Amphibious Groups; however, the requirement to outfit every Carrier and Amphibious Group needs to be evaluated and validated. Because the peacetime deployment requirements are limited for the Carrier and

Amphibious Groups, the Navy needs to determine the feasibility and cost-effectiveness of cross-decking VTUAV assets to enable the Navy to use available resources for other higher priority requirements. The need for the Navy to document an analysis of requirements is equally important in support of current mobilization efforts that provide for homeland defense.

Conclusion

The Navy had not justified the number of Vertical Take-off and Landing Tactical Unmanned Aerial Vehicles that were stated as Navy and Marine Corps requirements because the Deputy Chief of Naval Operations (Warfare Requirements and Programs) had not documented an analysis of the requirements determination. Until the Navy validates the requirements through a documented analysis, the Navy will not know whether it will be able to fully fund, through programming and budgeting, the VTUAV program in the Future Years Defense Program.

Recommendation

B. We recommend that the Deputy Chief of Naval Operations (Warfare Requirements and Programs) document an analysis to justify the number of Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle systems required before the full-rate production decision scheduled for the second quarter of FY 2003. At a minimum, the justification should include the quantities and associated rationale for both peacetime and wartime scenarios, and assess the viability and cost-effectiveness of transferring, or cross-decking, Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle assets between deployed and nondeployed ships.

Management Comments Required

The Deputy Chief of Naval Operations (Warfare Requirements and Programs) did not comment on a draft of this report. We request that the Deputy Chief of Naval Operations comment on the final report.

C. Program-Specific Exit Criteria

The VTUAV Program Manager proposed, and the Assistant Secretary of the Navy (Research, Development and Acquisition) approved, exit criteria that were based on minimum program accomplishments specified for each acquisition phase rather than on program-specific accomplishments. This condition occurred because the Assistant Secretary of the Navy (Research, Development and Acquisition) did not enforce the requirement that the VTUAV Program Manager propose program-specific exit criteria for the full-rate production decision point of the VTUAV acquisition program. As a result, the milestone decision authority will not be able to use program-specific exit criteria in deciding whether the VTUAV should progress within the engineering and manufacturing development phase or continue to the production phase of the acquisition process.

Exit Criteria Requirements

The DoD included the requirement for establishing exit criteria as a management tool for use in the acquisition process in the February 23, 1991, version of DoD Instruction 5000.2, "Defense Acquisition Management Policies and Procedures." The Instruction required that the milestone decision authority, at milestone decision points, establish program-specific results, or exit criteria, for the next phase(s) of the acquisition process for Defense acquisition programs. The Instruction defined exit criteria as critical results that must be attained during the next acquisition phase, and stated that failure to meet the exit criteria would halt the progress of a system towards the next milestone decision point. Furthermore, the Instruction required that exit criteria be program-specific accomplishments that did not repeat the minimum required accomplishments for each acquisition phase contained in the Instruction and in the acquisition program baseline.

The Under Secretary of Defense for Acquisition and Technology[3], incorporated the exit criteria requirements of DoD Instruction 5000.2 in DoD Regulation 5000.2-R, March 15, 1996. DoD Regulation 5000.2-R states that the exit criteria should be a level of demonstrated performance (for example, a level of engine thrust), the accomplishment of a process at a certain level of efficiency (for example, manufacturing yield) or a successful accomplishment of an event (for example, first flight), which shows that the program is progressing satisfactorily toward program goals. Program-specific exit criteria, such as the examples given, provide the milestone decision authority assistance in measuring whether the program is progressing satisfactorily toward the program goals.

For major DoD acquisition programs, the Regulation requires that the milestone decision authority establish exit criteria for the program definition and risk reduction phase (Phase I) and the engineering manufacturing development phase (Phase II) of the acquisition process. The Regulation requires that the milestone

[3]Renamed the Under Secretary of Defense for Acquisition, Technology, and Logistics in October 1999.

decision authority document the exit criteria in the acquisition decision memorandum before the program enters each acquisition phase. Change 4 to DoD Regulation 5000.2-R, May 11, 1999, added the requirement that the milestone decision authority establish exit criteria for the low-rate initial production decision at the engineering and manufacturing development decision point. The June 10, 2001, version of the DoD Regulation 5000.2-R incorporated the same exit criteria requirements.

The requirements in the Regulation are to serve as a model for managing other than major Defense acquisition programs. Secretary of Navy Instruction 5000.2B, "Implementation of Mandatory Procedures for Major and Non-Major Defense Acquisition Programs and Major and Non-Major Information Technology Acquisition Programs," December 6, 1996, extends the requirement for using exit criteria as defined in DoD Regulation 5000.2-R to all Navy weapon system programs.

VTUAV Exit Criteria

In an Acquisition Decision Memorandum dated February 8, 2000, the Assistant Secretary of the Navy (Research, Development and Acquisition) approved the VTUAV program to proceed into the engineering and manufacturing development phase of the acquisition process. The Memorandum documented the approved exit criteria for low-rate initial production 1 and 2, and engineering and manufacturing development. The Navy defined the low-rate initial production 1 as the fielding of one Marine system and low-rate initial production 2 as the fielding of one Navy system. The VTUAV Program Manager proposed exit criteria for key decisions.

Low-Rate Initial Production 1

Completion of an operational assessment by the Naval Commander, Operational Test and Evaluation Force, which indicates that the VTUAV system is potentially operationally suitable and effective.

Successful completion of a critical design review or similar activity.

Low-Rate Initial Production 2

Successful completion of Development Test-IIA flight testing.

Engineering and Manufacturing Development

Completion of operational evaluation with a finding by Naval Commander, Operational Test and Evaluation Force, that the VTUAV Program is operationally suitable and effective.

Favorable production readiness review report.

The exit criteria are not program specific; they simply restate critical requirements in DoD Regulation 5000.2-R that the milestone decision authority must consider at the milestone decision review. To illustrate, the Regulation requires that the program manager demonstrate, through testing, that the system

is potentially operationally effective and suitable before the low-rate production decision. Similarly, before the full-rate production decision, the Regulation requires that the program manager demonstrate that the system is operationally effective and suitable.

Conclusion

Properly established exit criteria are tools that the milestone decision authority uses to verify that the program has met the level of performance required to progress to the next phase of the acquisition process. The exit criteria established by the VTUAV Program Office cannot be used in the manner intended by DoD Regulation because they were not program specific. In the absence of program-specific exit criteria for the VTUAV program, the Assistant Secretary of the Navy (Research, Development and Acquisition) will be unable to use exit criteria as a management tool at milestone decision reviews to determine whether the program is ready to progress to the next phase of the acquisition process.

Recommendation

C. We recommend that the Assistant Secretary of the Navy (Research, Development and Acquisition) enforce the requirement that the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle Program Manager propose program-specific exit criteria for the full-rate production decision point of the Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle acquisition program.

Management Comments Required

The Assistant Secretary of the Navy (Research, Development and Acquisition) did not comment on a draft of this report. We request that the Assistant Secretary of the Navy (Research, Development and Acquisition) comment on the final report.

Appendix A. Audit Process

Scope

We conducted this program audit from February 2001 through September 2001, and reviewed documentation dated from January 1990 through August 2001. We used criteria in DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," Change 4, May 11, 1999, to perform the audit. To accomplish the audit objectives, we took the following steps:

- determined whether the users had adequately defined the system requirements;
- determined whether the program office had developed and implemented an acquisition plan, a risk management plan, and a test and evaluation plan;
- evaluated the Defense Contract Management Agency's involvement in monitoring the contractor's earned value management process;
- evaluated the program office's management of contracts for the program;
- determined whether the program office had a fully developed, programmatic, environmental, safety, and health evaluation;
- assessed the program office's implementation of the DoD environmental management process;
- determined whether the program office had prepared a life-cycle cost estimate for the program;
- evaluated program office use of integrated product teams; and
- reviewed management controls related to the audit objective.

General Accounting Office High-Risk Area. The General Accounting Office has identified several high-risk areas in the DoD. This report provides coverage of the DoD Weapons System Acquisition high-risk area.

Methodology

Audit Type and Standards. We performed this program audit in accordance with generally accepted government auditing standards.

Use of Computer-Processed Data. We did not use computer-processed data to perform this audit.

Contacts During the Audit. We visited or contacted individuals and organizations within the DoD and contractor locations. Further details are available upon request.

Management Control Program Review

DoD Directive 5010.38, "Management Control (MC) Program," August 26, 1996, and DoD Instruction 5010.40, "Management Control (MC) Program Procedures," August 28, 1996, require DoD organizations to implement a comprehensive system of management controls that provides reasonable assurance that programs are operating as intended and to evaluate the adequacy of the controls.

Scope of the Review of the Management Control Program. In accordance with DoD Regulation 5000.2-R, June 10, 2001, acquisition managers are to use program cost, schedule, and performance parameters as control objectives to implement the requirements of DoD Directive 5010.38. Accordingly, we limited our review to management controls directly related to those elements of the VTUAV program. Because we did not identify a material weakness, we did not assess management's self-evaluation.

Adequacy of Management Controls. The Program Executive Office Cruise Missiles and Joint Unmanned Aerial Vehicles management controls were adequate in that we identified no material management control weakness.

Prior Coverage

During the last 5 years, the General Accounting Office; the Inspector General, DoD; and the Naval Audit Service have not issued reports specifically addressing the VTUAV.

Appendix B. Definitions of Technical Terms

Acquisition Category. An acquisition category is an attribute of an acquisition program that determines the program's level of review, decision authority, and procedures. The acquisition categories consist of I, major Defense acquisition programs; IA, major automated information systems; II, less than major systems; and III, all other acquisition programs. In addition, Acquisition Category I programs have two subcategories: Acquisition Category ID programs, where the milestone decision authority is the Under Secretary of Defense for Acquisition, Technology, and Logistics, and Acquisition Category IC programs, where the milestone decision authority is the Component Acquisition Executive.

Acquisition Phase. An acquisition phase represents all the tasks and activities needed to bring a program to the next major milestone. Phases provide a logical means of progressively translating broadly stated mission needs into well-defined, system-specific requirements and, ultimately, into operationally effective, suitable, and survivable systems.

Acquisition Strategy. An acquisition strategy is a business and technical management approach designed to achieve program objectives within the resource constraints imposed. It is the framework for planning, directing, contracting for, and managing a program. It provides a master schedule for research, development, test, production, fielding, modification, postproduction management, and other activities essential for program success. The acquisition strategy is the basis for formulating functional plans and strategies.

Engineering and Manufacturing Development. Engineering and manufacturing development is the third phase of the acquisition process where the program office and its contractors fully develop, engineer, design, fabricate, test, and evaluate the systems and the principal items necessary for its support.

Exit Criteria. Exit criteria are program-specific accomplishments that must be satisfactorily demonstrated before a program can progress further in the current acquisition phase or continue to the next acquisition phase.

Full-Rate Production. Full-rate production is contracting for economic production quantities following stabilization of the system design and validation of the production process.

Initial Operational Capability. The first attainment of the capability to employ effectively a weapon, item of equipment, or system of approved specific characteristics with the appropriate number, type, and mix of trained and equipped personnel necessary to operate, maintain, and support the system. It is normally defined in the operational requirements document.

Joint Requirements Oversight Council. The Joint Requirements Oversight Council is responsible to the Chairman of the Joint Chiefs of Staff for assessing military requirements in support of the defense acquisition process. The Vice Chairman of the Joint Chiefs of Staff chairs the Council and decides all matters before the Council. The permanent members include the Vice Chiefs of the U.S. Army, and U.S. Air Force, the Vice Chief of Naval Operations, and the Assistant Commandant of the Marine Corps. The Council directly supports the Defense Acquisition Board though the review, validation, and approval of key cost, schedule, and performance parameters at the start of the acquisition process, prior to each milestone review, or as requested by the Under Secretary of Defense for Acquisition and Technology.

Low-Rate Initial Production. Low-rate initial production is the production of a system in limited quantities to provide articles for additional operational test and evaluation, to establish an initial production base, and to permit an orderly increase in the production rate that will lead to full-rate production after successful completion of operational testing.

Milestone. A milestone is the point where the milestone decision authority decides whether to start or continue an acquisition program in the acquisition process.

Milestone Decision Authority. A milestone decision authority is the individual designated in accordance with criteria established by the Under Secretary of Defense for Acquisition, Technology, and Logistics to approve entry of an acquisition program into the next phase of the acquisition process.

Production Representative. A production representative system is a system in its final configuration, conforming to production specifications and drawings.

Appendix C. Acquisition Phases

DoD Regulation 5000.2-R requires that acquisition strategies for all weapon systems be event driven, and identifies acquisition program phases and events to be accomplished for acquisition programs. The June 10, 2001, version of the Regulation changes the phase numbers to letters, but the requirement for an event-driven acquisition strategy and the events to be accomplished in each phase remain the same. Following are the acquisition phases as defined in the May 11, 1999, revision of the Regulation.[1]

Phase 0, Concept Exploration. Phase 0 typically consists of competitive, parallel, short-term concept studies. The focus of those studies is to define and evaluate the feasibility of alternative concepts and to provide a basis for assessing the relative merits of those concepts at the next milestone decision point. An analysis of alternatives shall be used as appropriate to facilitate comparisons of alternative concepts. The most promising system concepts shall be defined in terms of initial, broad objectives for cost, schedule, performance, software requirements, opportunities for tradeoffs, overall acquisition strategy, and test and evaluation strategy.

Phase I, Program Definition and Risk Reduction. During Phase I, the program shall become defined as one or more concepts, design approaches, and/or parallel technologies are pursued as warranted. Assessments of the advantages and disadvantages of alternative concepts shall be refined. Prototypes, demonstrations, and early operational assessments shall be considered and included as necessary to reduce risk so that technology, manufacturing, and support risks are well in hand before the next decision point. Cost drivers, life-cycle cost estimates, cost-performance trades, interoperability, and acquisition strategy alternatives shall be considered, including evolutionary and incremental software development.

Phase II, Engineering and Manufacturing Development. The primary objectives of Phase II are to translate the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing or production process; and demonstrate system capabilities through testing. Low-rate initial production occurs during the engineering and manufacturing development phase, as test results and design fixes or upgrades are incorporated. The objective of low-rate initial production is to produce the minimum quantity necessary to provide production configured or representative articles for operational tests; establish an initial production base for the system; and permit an orderly increase in the production rate for the system, sufficient to lead to full-rate production upon successful completion of operational testing.

Phase III, Production, Fielding/Deployment, and Operational Support. The objectives of Phase III are to achieve an operational capability that satisfies mission needs. Deficiencies encountered in developmental test and evaluation and initial operational test and evaluation shall be resolved and fixes verified in

[1]The VTUAV program is subject to the May 11, 1999, version of DoD Regulation 5000.2-R because the program entered the engineering and manufacturing stage of the acquisition process before the June 10, 2001, revision of the Regulation.

follow-on operational test and evaluation. During fielding/deployment and throughout operational support, the potential for modifications to the fielded/deployed system continues. The objectives of operational support are the execution of a support program that meets the threshold values of all support performance requirements and sustainment of them in the most cost-effective manner throughout the system's life cycle. A follow-on operational testing program that assesses performance and quality, compatibility, and interoperability, and identifies deficiencies shall be conducted, as appropriate. The program shall also include the execution of operational support plans, including the transition from contractor to organic support, if appropriate.

Appendix D. Technology Readiness Levels

Technology Readiness Level	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into the technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. After the basic principles have been observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated.
4. Component and/or breadboard[1] validation in laboratory environment.	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.

[1]A board on which components are mounted for feasibility testing.

Technology Readiness Level	Description
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond the breadboard tested for level 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from level 6, requiring the demonstration of an actual system prototype in an operational environment. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this level represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

Appendix E. Carrier Groups and Amphibious Groups

Carrier Groups

Composition of a Carrier Group. A Carrier Group is a highly balanced mix of ships and aircraft capable of conducting a variety of missions including strike operations, humanitarian assistance, sea control, and power projection. A Carrier Group generally consists of an aircraft carrier, two cruisers, three destroyers, two frigates, two submarines, and a supply ship.

Availability. The Navy has 12 aircraft carriers that serve as the focal point of a Carrier Group. The maintenance schedule for the 12 aircraft carriers showed that, through FY 2008, 9 carriers, on average, are available for deployment at any given time. The remaining three aircraft carriers are out of service for refueling or incremental maintenance. Although two of the remaining three carriers can be deployed on short notice, this condition would occur only in an emergency scenario.

Amphibious Groups

Composition of an Amphibious Group. An Amphibious Group is a naval expeditionary force consisting of an amphibious squadron normally composed of three ships with an embarked Marine Expeditionary Unit.[1] Amphibious Groups are able to rapidly project forces ashore by land or sea. Forward-deployed Amphibious Groups provide the Commanders in Chief with a wide array of capabilities to include sustained maritime presence, rapid crisis response, humanitarian relief, peace support, and amphibious forcible entry.

Availability. The Navy has 11 large deck, amphibious ships, each serving as the focal point of an Amphibious Group. The deployment schedule of the 11 Amphibious Groups showed that for 2000 and 2001, only 3 Amphibious Groups, on average, were scheduled for deployment or were in transit at any given time. The other eight Amphibious Groups were used in training or were out of service for maintenance. Unlike the Carrier Groups, none of the Amphibious Group lead ships were scheduled for long maintenance cycles; therefore, all were available for deployment on short notice.

[1]An intervention force able to move quickly on short notice to wherever it is needed to accomplish conventional or special operations.

Appendix F. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense (Comptroller)
  Deputy Chief Financial Officer
  Deputy Comptroller (Program/Budget)
Chairman, Joint Requirements Oversight Council

Department of the Army

Auditor General, Department of the Army

Department of the Navy

Assistant Secretary of the Navy (Research, Development and Acquisition)
  Program Executive Officer, Strike Weapons and Unmanned Aviation
Assistant Secretary of the Navy (Manpower and Reserve Affairs)
Naval Inspector General
Deputy Chief of Naval Operations (Warfare Requirements and Programs)
Auditor General, Department of the Navy

Department of the Air Force

Assistant Secretary of the Air Force (Financial Management and Comptroller)
Auditor General, Department of the Air Force

Non-Defense Federal Organization

Office of Management and Budget

Congressional Committees and Subcommittees, Chairman and Ranking Minority Member

Senate Committee on Appropriations
Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
House Committee on Armed Services
House Committee on Government Reform
House Subcommittee on Government Efficiency, Financial Management, and Intergovernmental Relations, Committee on Government Reform
House Subcommittee on National Security, Veterans Affairs, and International Relations, Committee on Government Reform
House Subcommittee on Technology and Procurement Policy, Committee on Government Reform

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